OFFICE OF
RIVER PROTECTION
United States Department of Energy

Vitrifying Hanford Tank Waste

Oregon Hanford Cleanup Board

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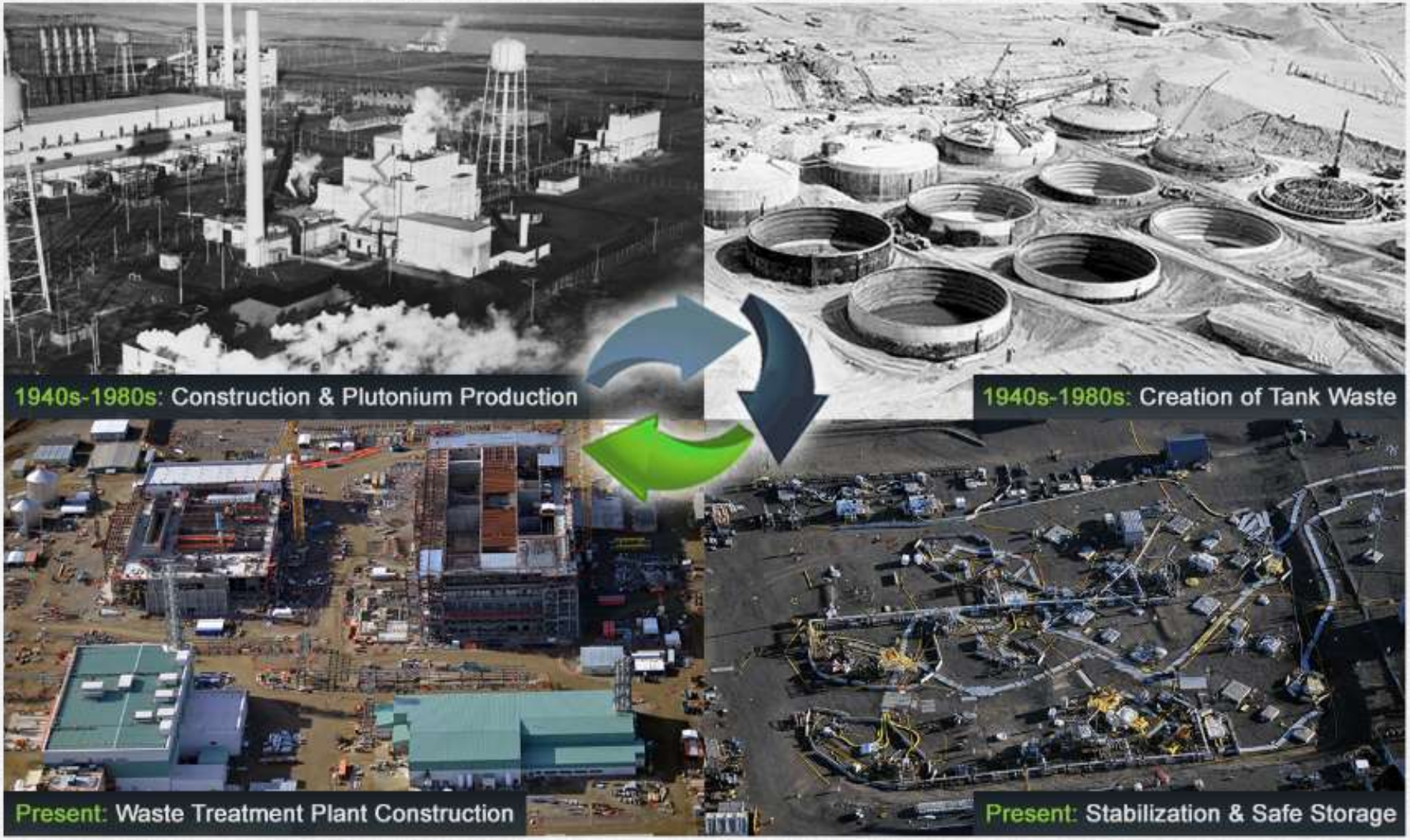
November 28, 2017

Hanford Historical Overview



Tank Farm Mission

Safely maintain 56 million gallons of radioactive and chemical waste

- 1943-1964: 149 single-shell tanks (SST)
- 1968-1986: 28 double-shell tanks (DST)

What's in the Tanks

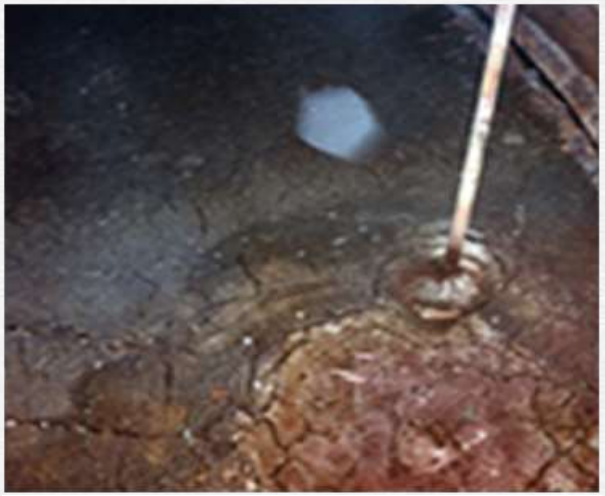
Saltcake
23M gallons

Mostly water-soluble salts; small amount of interstitial liquid

Supernate
21M gallons

Any non-interstitial liquid in the tanks – similar to saltcake in composition

Sludge
12M gallons



Water-insoluble metal oxides, significant amount of interstitial liquid – texture similar to peanut butter

Generation of Hanford Tank Wastes

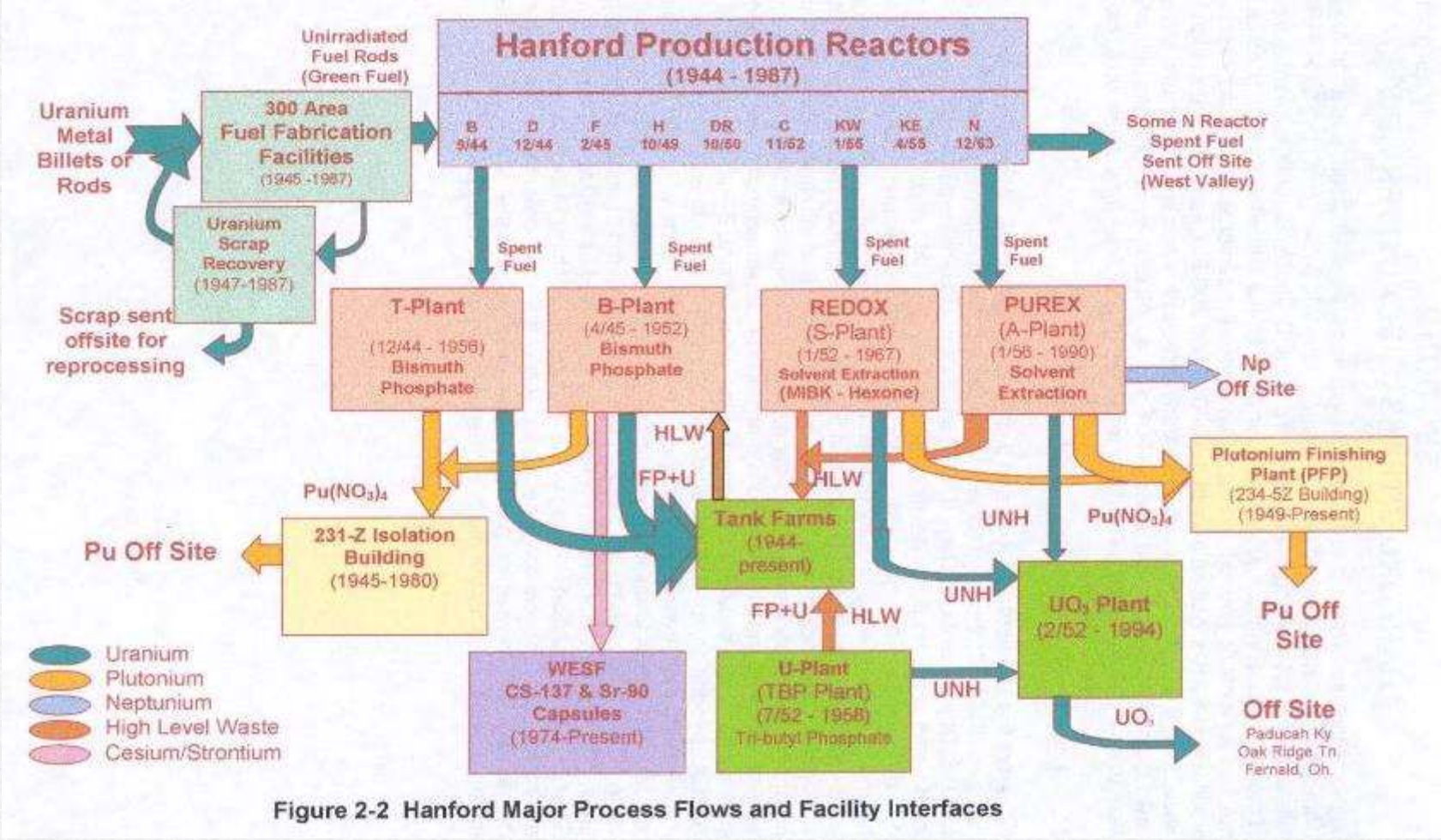
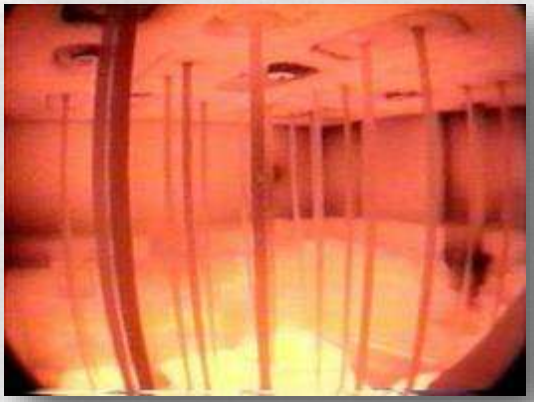


Figure 2-2 Hanford Major Process Flows and Facility Interfaces

9 Reactors; 4 Fuel Reprocessing Flowsheets; 100,000 MT Fuel Processed

Waste Treatment and Immobilization Plant (WTP)

WTP Mission: Immobilize Waste in Glass



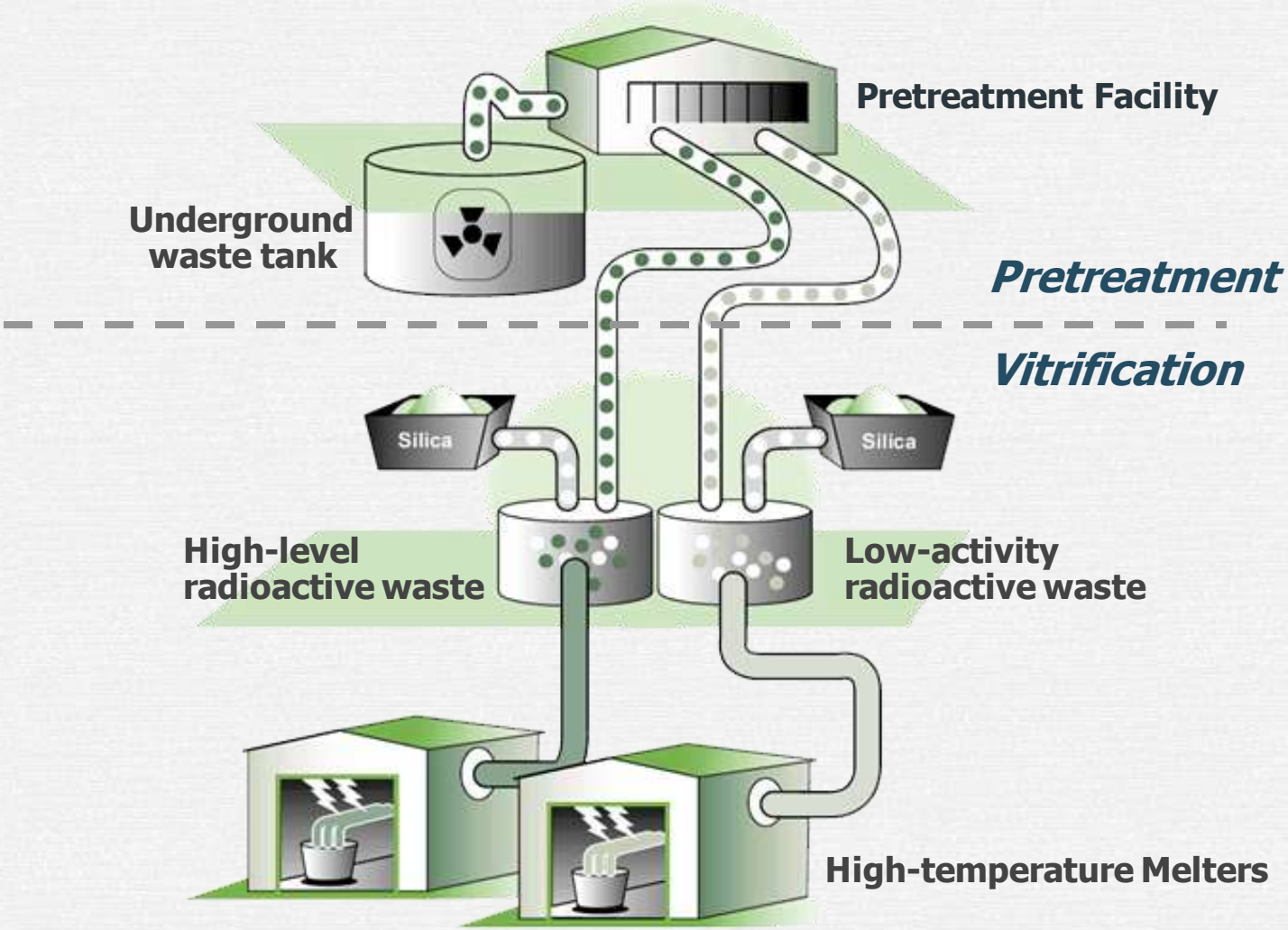
Molten glass and waste in a melter

Simulated vitrified waste

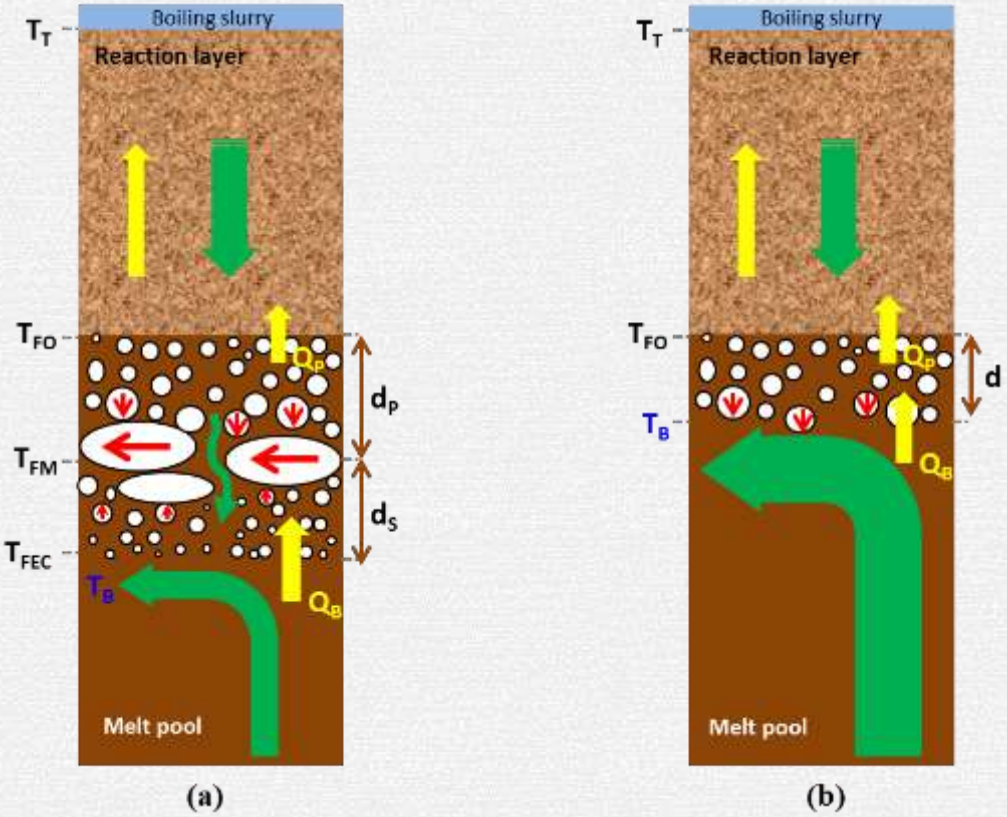
High-level waste (tall) canister and low-activity waste container

Simulated vitrified waste in a canister

WTP Vitrification Process



Enhanced Heat Flux By Bubbling



- Primary foam related to CO2 gas goes down, grows, coalesces, and creates a cavity in the foam layer.
- Secondary foam related to O2 gas goes up and accumulates under the cavity (or some foam maybe burst into the cavity) in the bottom of the cold cap.
- Gases in the cavity tends to move to the side of the cold cap and burst to atmosphere.

Selected Pellet Photos

AN-102

625°C

675°C

725°C

775°C

AZ-102

820°C

860°C

AN-102

AZ-102

High-Level Waste Vitrification

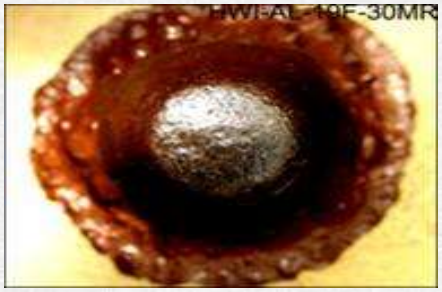
Small-Scale Melt Rate

30 min

45 min

60 min

Initial Formulation



30 min

60 min

Improved Formulation

Improvements confirmed in one-third scale pilot melter tests

VSL-08R1360-1, Rev.0; VSL-10R1690-1, Rev. 0

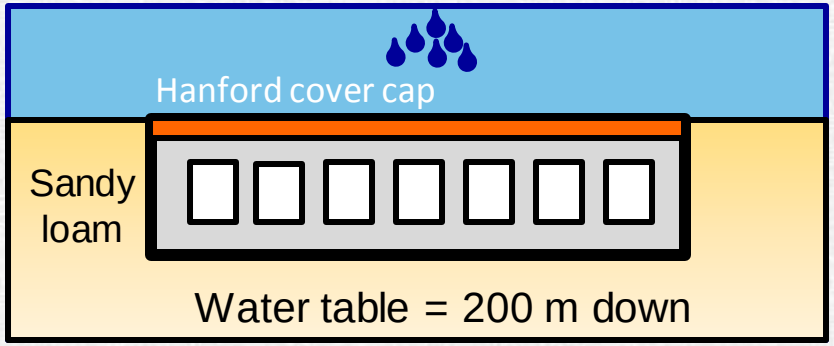
Low-Activity Waste Vitrification

Integrated Disposal Facility

Low-Activity Waste (LAW) glass will immobilize:

- Long-lived semi-volatile anions: $^{99}TcO4$ (half-life 213,000 years) and ^{129}I (half-life 15.7 million years)
- Toxic metals: Cr, Ni, V
- High alkali content (Na and K)

- Average temperature: 60° F
- Rainfall: less than 7 inches per year



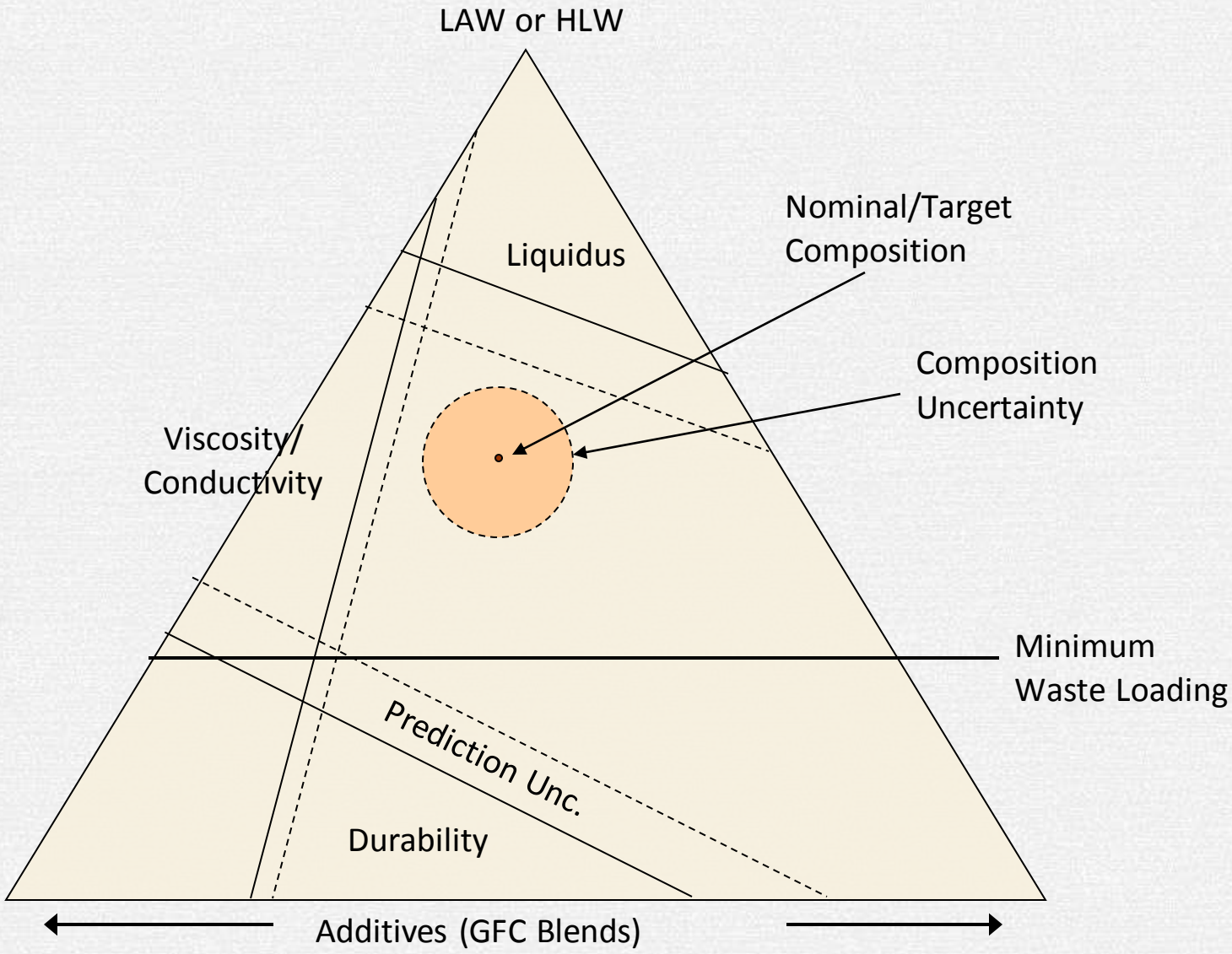
Enhanced Glass Model Impact on Treatment Mission

	BNI/WTP Baseline Models	2008 TUA* Baseline	2013 TUA Baseline	2013 TUA w/ caustic and oxidative leaching eliminated
HLW Canisters	18,400	14,838	8,223	13,534
LAW Containers	145,000	91,400	79,465	65,151
Total Canisters & Containers	163,000	106,238	87,688	78,685

* The "2008 models" were altered in anticipation of our work

24590-WTP-RPT-PE-13-003, Rev 0, 2013 Tank Utilization Assessment (TUA) Part 1: Potential Impact of Advanced Glass Models on the WTP, 3 December 2013

Schematic of Processing Window



Next Steps

Project Objectives

The GLAD Project

Aim: To design a new test for LAW glass that is more representative of low temperature corrosion

Develop a low temperature glass corrosion test

↓

Confirm ease and reproducibility between three laboratories

↓

Exchange the controversial VHT test for the new test

The Hillfort Project

Aim: To validate the chosen low temperature test against natural analogues from 2,000-year-old Swedish Hillforts

Take glass samples from Swedish Hillfort

↓

Study corrosion and corrosion environment

↓

Make glass of identical composition

Apply test to Hillfort glasses and validate

Project Objectives

- Determine the long-term durability of Broborg hillfort glass to support putting Hanford low-activity waste (LAW) glass in the Integrated Disposal Facility (IDF)
- Provide further insight into the anthropological and archeological interpretation of the Broborg Hillfort Site, Sweden

Glass analogues can be used to assess performance LAW glass for storage of radioactive waste for 10,000+ years

Broborg Excavation Phase 2, Fall 2017

- Excavating down to original structure to obtain information on:
  - Broborg construction and history
  - Glass samples transecting wall to study thermal history, alteration and microbial impacts
  - Oriented glass samples for paleomagnetometry
  - Carbon dating charcoal and bone fragments from cooking fires

Summary & Conclusions

- Broborg glasses fulfill several important prerequisites for good analogues for nuclear waste glass:
  - Similar chemical composition
  - Similar mechanisms of corrosion
  - Alteration in similar, known environmental conditions

Questions?


The Hanford Reach
White Bluffs Overlooking the Columbia River